Studies on the use of biochar as soil amendments have been attracting a lot of scientific interest. Biochar not only enhances some soil fertility-related soil properties, but can also sequester soil carbon resulting in mitigation of global warming. Biochar characteristics vary with their production conditions, i.e., feedstock and pyrolysis techniques. In addition, their effectiveness as soil amendments may vary in different soils.

HYPOTHESES

Hyp. 1. Thai conventional kiln (TK) will produce biochar which has higher volatile (VW) content but lower ash and fixed C than Flash carbonization (FC) technique. Additionally, TK biochar will have lower C content but higher O, H, and N content than FC biochar.

Hyp. 2. Biochar will improve soil properties and plant growth more in the sandy (Khorat) soil than the clayey (Wahiawa) soil.

Hyp. 3. FC biochar will be more effective in improving soil properties and plant growth than the TK biochar.

Hyp. 4. Increasing biochar application rate will increase soil enhancement and plant growth.

OBJECTIVE

To evaluate effects of biochar produced under contrasting pyrolysis techniques and their application rates on plant biomass and properties of soils contrasting in texture and mineralogy.

MATERIALS AND METHODS

BIOCHAR

Biochar was produced from the upper part of 5-year-old eucalyptus (Eucalyptus camaldulensis) wood under different pyrolysis techniques (Fig 1): (a) Thai conventional kiln (TK), and (b) flash carbonization (FC) reactor.

Pyrolysis Conditions of Biochar Production

TK biochar was produced at 500°C in a clay kiln (Fig 1a). FC biochar was produced under a controlled flash fire at 1 MPa for 40 min with peak temperature reaching 800°C in the reaction chamber (Fig 1b).

PROPERTIES

Biochar proximate analysis: i.e., volatile matter, ash, and fixed carbon contents, was analyzed using ASTM D 1762-84 standard method, while ultimate analysis: i.e., element contents, and ash composition were conducted by Hazen Research Inc., Golden, Colorado (Table 1).

SOIL

Soils with contrasting texture and mineralogy were used (Table 2): Khorat soil series (loamy sandy, isohyperthermic Typic Oxyaquudultis), which was collected from 0–15 cm depth soil in Fruit Tree station, Khon Kaen University, Thailand. Wahiawa soil series (very fine, kaolinitic, isohyperthermic, Rhodic Hapludult) was collected from 0–15 cm depth soil at the Poamoho Research Station, University of Hawaii, USA.

EXPERIMENTAL DESIGN

A greenhouse pot experiment was conducted in the University of Hawaii, USA testing two corn crop cycles. The experiment was arranged in a 2 x 4 factorial arrangement in randomized complete block design with three replications.

RESULTS AND DISCUSSION

EFFECT OF PRODUCTION TECHNIQUE ON BIOCHAR PROPERTIES

TK biochar showed less thermal alteration with higher VW and lower ash and fixed carbon content than the FC biochar (Table 3). TK biochar had lower percentage of C but higher O, H, and N than FC biochar; further evidence that the FC biochar experienced a higher degree of carbonization.

Elements which were related to ash content were higher in FC than in TK. Therefore, Hyp. 1 was accepted.

EFFECT OF BIOCHAR CHARACTERISTICS ON SOIL PROPERTIES AND CORN GROWTH

Biochar showed minimal effects on plant growth during crop cycle 1 (data not shown).

Biochar significantly increased plant growth in the crop cycle 2 with significant soil, biochar, and rate effects (Table 4).

CONCLUSION

Biochar properties varied significantly depending on pyrolysis conditions.

Biochar effects were more pronounced in the sandy Khorat soil than in clay Wahiawa soil.

Contrary to expectations, the TK biochar improved soil properties and plant growth more effectively than the FC biochar.

Increasing biochar application rate increased soil enhancement and plant growth, except the highest rate.

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SELECTED REFERENCE